SAIL: automating interlibrary loan*

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The National Library of Medicine (NLM) initiated the System for
Automated Interlibrary Loan (SAIL) pilot project to study the
feasibility of using imaging technology linked to the DOCLINE®
system to deliver copies of journal articles. During the project, NLM
converted a small number of print journal issues to electronic form,
linking the captured articles to the MEDLINE citation unique
identifier. DOCLINE requests for these journals that could not be
filled by network libraries were routed to SAIL. Nearly 23,000 articles
from sixty-four journals recently selected for indexing in Index
Medicus were scanned to convert them to electronic images. During
fiscal year 1992, 4,586 scanned articles were used to fill 10,444
interlibrary loan (ILL) requests, and more than half of these were
used only once. Eighty percent of all the articles were not requested
at all. The total cost per article delivered was $10.76, substantially
more than it costs to process a photocopy request. Because conversion
costs were the major component of the total SAIL cost, and most of
the articles captured for the project were not requested, this model
was not cost-effective. Data on SAIL journal article use was compared
with all ILL requests filled by NLM for the same period. Eighty-eight
percent of all articles requested from NLM were requested only once.
The results of the SAIL project demonstrated that converting journal
articles to electronic images and storing them in anticipation of
repeated requests would not meet NLM's objective to improve
interlibrary loan.

In fiscal year 1992, the National Library of Medicine
(NLM) received more than 300,000 interlibrary loan
(ILL) requests, including approximately 11% of the
2.4 million requests input to DOCLINE®, NLM's au-
tomated ILL request routing-and-referral system used
by U.S. medical libraries. The demand of approxi-
mately 1,400 requests a day has resulted in not only
an increased workload for a limited staff but also
increased wear and tear on the journals that NLM
must preserve for future generations.

NLM has implemented numerous improvements
to the ILL requesting system. With DOCLINE, NLM
has greatly increased the speed and efficiency with
which ILL requests are generated and transmitted
among medical libraries throughout the country. NLM

now receives 86% of its ILL requests through DOC-
LINE. The LOANSOME DOC™ system links the phy-
sician or other health professional through GRATE-
FUL MED® NLM's PC-based retrieval software, to
one of the 2,500 network libraries using DOCLINE.
In 1991, in an effort to speed document delivery for
health care, NLM began to accept and respond to ILL
requests for clinical emergencies using fax, and the
library now supplies articles by fax whenever re-
quested by another library.

THE SAIL SYSTEM

In 1990, NLM began the System for Automated In-
terlibrary Loan (SAIL) project to investigate the po-
tential for incorporating imaging technology into the
document delivery process. The communications en-
gineering branch of NLM's Lister Hill National Cen-
ter for Biomedical Communications had developed a

Figure 1
SAIL system overview
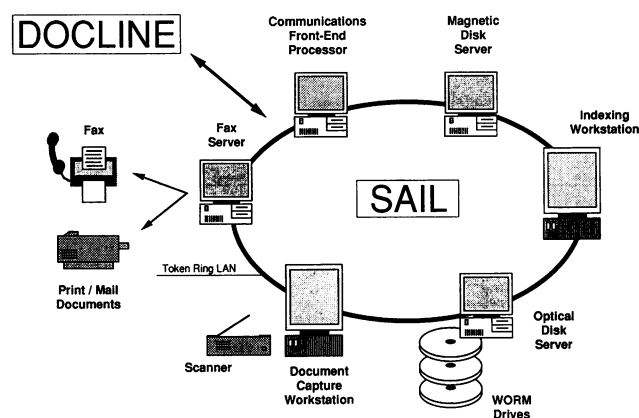
document-imaging system for research on capturing and enhancing images of old, bound, brittle materials for preservation. A report on the Lister Hill Center's document-imaging preservation research was completed in 1989 [1]. For the SAIL project, the electronic imaging workstation was modified and combined with several other workstations and systems. The result was a prototype system to link NLM's ILL service through DOCLINE so that requests for articles from titles that were preserved on optical disk could be identified, retrieved, and transmitted automatically from NLM to the requesting library [2–3]. The objective was to determine whether such a system was feasible in an operational environment and whether it could be cost-effective.

The SAIL system is a complex of six networked PC subsystems, some of which are used for scanning and creating SAIL's image database (the input process), others performing document delivery (the output process), and some shared by both the input and output processes (Figure 1).

■ The Communications Front-End Processor serves as a "gateway" to the automated system, interfacing SAIL to DOCLINE. The processor automatically calls the NLM mainframe and logs into DOCLINE daily, every fifteen minutes from 7:15 A.M. to 9:45 P.M. eastern standard time, the hours when DOCLINE is available. It retrieves ILL requests through the DOCLINE Receipt function, notifies DOCLINE of the status of requests, and then logs off.

■ The Magnetic Disk Server provides temporary storage for images produced by the document capture process. It also provides temporary storage for images to be delivered. The other five SAIL subsystems share the images and databases on the Magnetic Disk Server.

■ The Document Capture Workstation converts printed journals to electronic form. It consists of an 80386 central processing unit with an image compression board. Scanning for the project was at 200 dpi, which provided acceptable quality (better than photocopying) with reasonable efficient storage use.

■ The Optical Disk Server controls three Optimem 1000/M optical disk drives for image archiving and retrieval. Each drive handles a twelve-inch, 2.4-gigabyte WORM disk.

■ Two Indexing Workstations are used for quality control, to archive documents to optical disk, and to tag each document. Tagging is the process of identifying the images that belong to an article. These workstations also are used by the SAIL operator to browse the article data when SAIL has not been able to definitely identify the requested article from incomplete or incorrect data in the ILL request.

■ The Fax Server provides both printing and faxing functions. For items to be mailed, it prints the articles on a laser printer. For those to be faxed, it automatically sends the requested articles directly to the patron.

In implementing SAIL, no changes were made to the way in which libraries use the DOCLINE system. A library enters a request into DOCLINE or uploads a request from LOANSOME DOC to DOCLINE. DOCLINE searches for a potential lending library in the holdings of regional and local libraries identified in a routing table of up to 100 libraries. When DOCLINE encounters a request to be routed to NLM because no libraries in the routing table hold the requested item, the system checks the SERHOLD® record and, on the basis of journal title, decides whether to send it to SAIL or on to NLM's Collection Access Section for processing.†

Selection of journals for SAIL

To test SAIL efficiently during a limited-duration pilot project, NLM needed to select a group of materials that might be requested often. An analysis of ILL requests for titles most heavily requested from NLM showed that the majority of these serials very recently had been selected for indexing in *Index Medicus* (*IM*). Because libraries generally order new journals once a year, there is likely to be a period of two or more years before a title selected for *IM* is acquired widely and reported to SERHOLD. For the pilot project, NLM selected titles that had begun publication within the last three years, were newly selected for indexing in *IM*, and were published in English.

Approximately forty titles were selected initially for storage on optical disk, with additional titles add-

ed as they were selected for *IM*. Scanning began with volume 1 of each title. A second copy of each journal was purchased so that it could be unbound for scanning and subsequently discarded.

SAIL PILOT PROJECT

The SAIL Pilot Project was a cooperative project involving NLM's Lister Hill National Center for Biomedical Communications, which developed the hardware and software; several library operations groups including the Public Services Division, Serial Records Section, and Indexing Section; and the NLM computer center, which programmed the required changes in DOCLINE to link it with SAIL. Both conversion and delivery were done in the Lister Hill Center by library operations staff. Scanning began in 1991, and the SAIL pilot project operated until December 1992. In total, approximately 174,000 pages from sixty-four journal titles were scanned and stored on optical disk.

Input process

The input process was the most labor-intensive part of the process. Prior to indexing, the duplicate journal issue was checked in and a machine-readable indicator label assigned to the issue. The issues then were taken apart and scanned. Each page was inspected for legibility, distortion, skew, and other problems and rescanned as necessary. Once images were accepted, they were backed up on magnetic tape and then archived on optical disk. After archiving, they were ready to be tagged. The operator worked with a menu option for tagging each page as front cover, back cover, table of contents, new article, or a miscellaneous category covering advertisements, instructions to authors, and other topics. Once an issue was tagged, SAIL was ready to deliver it. Because the entire document capture process for each scanned issue was completed within twenty-four hours, the articles were available in SAIL before the citations were indexed and searchable in MEDLINE.

Output process

From information input at the tagging station, SAIL was able to identify articles requested in DOCLINE that included MEDLINE unique identifiers (UI). In response to requests, these articles were printed or faxed automatically, with no human intervention. DOCLINE requests that included the SERLINE UI, with citation information input by the requester, were passed to the Indexing Workstation, where an operator, with assistance from the workstation software, identified the correct article and directed SAIL to fill the request. If the operator was unsure, the article could be viewed on the screen to assist in the decision. Requests also could be held for an operator if the

appropriate optical disk was not mounted. By the end of the SAIL project, a total of nine optical disks were used to store images, and only three drives were available at one time, so the disk had to be changed often.

Images of articles routed to the Fax Server were either faxed or printed and mailed. SAIL inserted a copyright notice on the first page of the article and prepared a DOCLINE cover sheet. Requests that were faxed usually were filled only minutes after being input into DOCLINE. Printed requests (96% of all requests) were mailed twice daily.

RESULTS

During fiscal year 1992,‡ 12,338 ILL requests were routed to SAIL. SAIL filled 10,444, or 85% of the requests received. About 8% were not filled because requesters declined to pay NLM charges, and 7% were not filled for other reasons; for example, the documents were not yet in SAIL, they had not been tagged, or the requester wanted more pages than NLM's current policy allows. Approximately 30% of the requests filled were processed within fifteen minutes of receipt; those items were available on optical disk directly and included a MEDLINE UI. Another 50% of requests were filled within three hours; these requests required human intervention, either to exchange optical disks or to verify SAIL's tentative decision regarding the article requested.
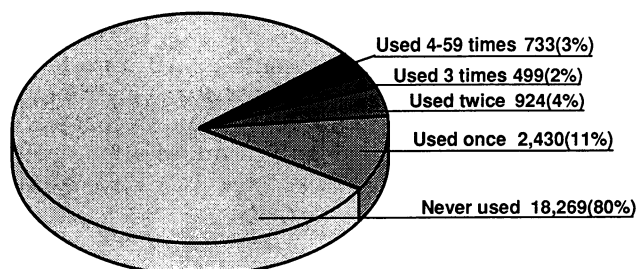
Journal article use in SAIL

As previously discussed, the journals selected for the SAIL project were chosen because, as new *IM* titles, requests would be routed to NLM until other medical libraries ordered these titles and reported them to SERHOLD. During the pilot project, nearly 23,000 articles covering two to four years of publication were scanned from sixty-four titles. All sixty-four titles were used at least once. Figure 2 shows the distribution of requests for articles scanned for SAIL. During the pilot, 4,586 articles were used to fill 10,444 requests; more than half of these articles were used only once. Most noteworthy is the fact that 18,269 (80%) of the articles scanned for the project were not requested at all, illustrating the shortcoming of an approach involving preselected documents.

SAIL costs

The total cost to scan and deliver articles during the pilot project was $8.76 per article, moderately higher than the cost of retrieving and photocopying articles from the NLM collection. The cost of conversion or

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‡ Federal government fiscal year: October 1, 1991, to September 30, 1992.

Figure 2
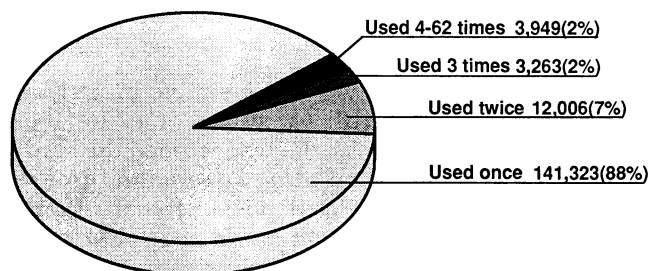Distribution of the 22,855 articles scanned for SAIL project

Used 4-59 times 733(3%)
Used 3 times 499(2%)
Used twice 924(4%)
Used once 2,430(11%)
Never used 18,269(80%)

Articles in SAIL

Figure 3
Distribution of articles used to fill 205,746 ILL requests at NLM in fiscal year 1992.

Used 4-62 times 3,949(2%)
Used 3 times 3,263(2%)
Used twice 12,006(7%)
Used once 141,323(88%)

Articles Used by NLM

input was $4.92. This cost is for scanning individual pages from unbound journals; scanning from bound journals would result in slightly higher costs. SAIL conversion costs include scanning and tagging entire journal issues; equipment, amortized over five years; and optical disk storage and associated labor costs. Output, or delivery costs, totaled $3.84, including labor costs; postage; all supplies, such as paper and toner; and National Technical Information Service (NTIS) charges for billing. The cost of the extra journal subscriptions was $2.06 per filled request, which would bring the total cost per delivered article to $10.76.

It should be noted that all these costs are "top down," meaning all costs incurred in the pilot project for conversion were totaled and divided by the number of articles scanned. All costs related to delivery were totaled and divided by the number of articles delivered during the pilot project. This approach was taken in order to arrive at costs that were comparable to the cost of NLM's manual ILL operation. The cost to process an ILL request for a photocopy at NLM at the time of the SAIL project was $7.36.

The cost analysis shows that conversion costs are the major component, and that the more times each

Table 1
Distribution of journal titles needed to fill ILL requests at NLM in fiscal year 1992

Number of journal titles	Number of ILLs filled	% ILLs filled
100	41,643	20
200	56,257	27
300	67,598	33
400	76,455	37
500	83,868	40
1,000	110,649	54
13,318	205,746	100

scanned title is used, the more cost-effective the system becomes. Unfortunately, results from the pilot project do not indicate a high level of multiple use for individual articles.

Requests filled

The findings on article use in the SAIL pilot showed that relatively few of the articles in newly indexed journals were requested during FY 1992. NLM data from the same year were analyzed to obtain similar use data for all ILL requests for journal articles.

Table 1 shows NLM data from FY 1992 for all filled serial ILL requests. That year, NLM used 13,318 unique journal titles to fill 205,746 ILL requests. Twenty percent of the requests were filled with just 100 titles; however, 500 titles were needed to fill 40% of the requests, 1,000 to fill half, and another 12,318 journal titles to fill all the requests. It must be noted that all years of publication of the journal were required to fill these requests.

Figure 3 shows the distribution of articles used to fill ILL requests received by NLM in fiscal year 1992. To fill the 205,000 requests, 160,541 unique articles were used. More than 141,000 of the articles were used only once. It is not possible to compare precisely the overall NLM data with SAIL data, because the total number of articles in all of NLM's 21,800 current journal subscriptions over all years of publication is not known. However, based on a figure of 100 articles per journal per year, one could estimate a total of 21.8 million articles over ten years of publication for these current journals. Using this estimate, 0.7% of the articles in the recent ten years of the NLM current collection have been used, compared with 20% of the SAIL articles, demonstrating that the SAIL articles were much more heavily requested than other articles at NLM, undoubtedly because they are not widely available throughout the network using DOCLINE.

FUTURE DIRECTIONS

The results of the SAIL pilot project demonstrated that converting journal articles to electronic images and storing them in anticipation of repeated requests would not meet NLM's objective of improving ILL services. Such a model would be cost-effective for only a very small number of journals that might be heavily requested for at least some period of time. Internal studies at NLM have shown that the most heavily requested titles change from year to year.

NLM will continue to work to improve the speed and reduce the costs of document delivery within the network. NLM's Lister Hill Center is working with the Division of Library Operations and the computer center to develop a prototype system for DOCLINE libraries that will enable them to send and receive articles over the Internet to other libraries and to LOANSOME DOC requesters. The system is called DOCVIEW. The vision for NLM and network libraries is an integrated work environment for document requesting and delivery to both the library and end user.

NLM will continue to use SAIL to fill requests for materials that are likely to be heavily requested and therefore cost-effective. At this writing, these materials include titles such as the *Clinical Practice Guidelines,* issued by the Agency for Health Care Policy and Research; *Clinical Alerts,* issued by the National Institutes of Health; and the *Morbidity and Mortality Weekly Report,* from the Centers for Disease Control and Prevention. SAIL is one part of NLM's solution to automated ILL.

ACKNOWLEDGMENTS

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